Scaling the ISiS fragment yields

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The ISiS fragment yields of 8 GeV/c π + Au were fit to a form of Fisher's droplet model incorporating the Coulomb energy release when a particle moves from liquid to vapor [1]:

$$n_A = q_0 A^{-\tau} \exp\left(\frac{A\Delta\mu + E_{Coul} - c_0\varepsilon A^{\sigma}}{T}\right), \quad (1)$$

where E_{Coul} is given by:

$$E_{Coul} = \frac{(Z_0 - Z)\,Z}{r_0\left((A_0 - A)^{1/3} + A^{1/3}\right)}\left(1 - e^{-x\varepsilon}\right). \quad (2)$$

Here Z_0 and A_0 are the charge and mass of the fragmenting system; $r_0 = 1.2$ fm; the mass of a fragment prior to secondary decay is $A = 2Z(1 + (E^*/B_f))$; Z is the measured fragment charge; E^* is the excitation energy; B_f is the binding energy of the fragment; the temperature T was determined via a Fermi gas: $T = \sqrt{E^*/(A_0/8(1 + E^*/B_0))}$; B_0 is the binding energy of the fragmenting system.

Over 500 data points for $1.5 \le E^* \le 6.0$ AMeV and $5 \le Z \le 15$ were simultaneously fit to Eq. (1) with $\Delta\mu$, x, τ, σ, c_0 and T_c varied to minimize χ^2_ν. Fragments with $Z < 5$ were excluded in the fit because Eq. (1) gives the energy of a fragment in terms of a bulk and surface, an approximation known to fail for light nuclei where structure details dominate. Also equilibrium/non-equilibrium production cannot always be differentiated for $Z < 5$. Fragments with $Z > 15$ were not elementally resolved and were excluded. Figure 1 shows the results.

The fragment yields are scaled by the power law pre-factor, bulk term and Coulomb term: $(n_A/q_0 A^{-\tau}\exp(\Delta\mu A + E_{Coul}/T))$; and plotted against $A^{\sigma}\varepsilon/T$. The scaled data collapse to the liquid-vapor coexistence line over six orders of magnitude.

The values of $\tau = 2.18 \pm 0.14$ and $\sigma = 0.54 \pm 0.01$ are in the range expected for three dimensional systems. The $\Delta\mu = 0.06 \pm 0.03$, may indicate a slightly super-saturated vapor. The value of x is 1.00 ± 0.06. The value of $c_0 = 18.3 \pm 0.5$ MeV is close to the surface energy coefficient of the liquid-drop model: 16.8 MeV. At the critical point the excitation energy is $E^*_c = 3.8 \pm 0.3$ AMeV and the temperature is $T_c = 6.7 \pm 0.2$ MeV.

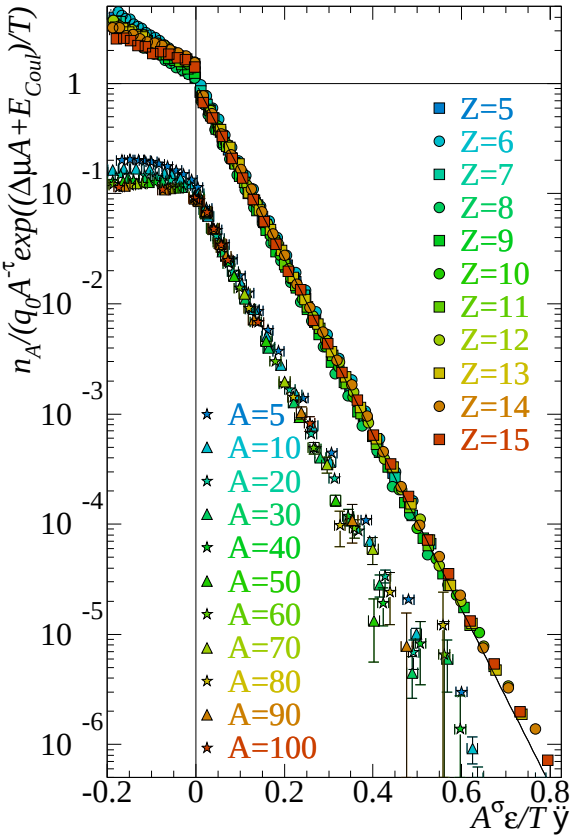

Figure 1: The scaled yields for the ISiS data (upper) and $d = 3$ Ising model calculation (lower).

References

[1] J. B. Elliott *et al.*, Phys. Rev. Lett. **88**, 042701 (2002).